Good Vibrations (Part 1 of 2):

[Adapted from *NASA's Museum in a Box*]

What is it?

The transfer of energy from one material to another can be measured in different ways. One that you may not initially think of is sound. Sound can be good, as it allows us to communicate and interact with our surroundings, but sound can also cause disturbance. For example, aircraft noise can be quite loud and cause disturbance in neighborhoods. Scientists and engineers are working hard to reduce these sounds in different ways.

In this activity, students will interact with tuning forks to learn about sound.

This activity discusses topics related to National Science Education Standards:

4-PS4-3: *Generate and compare multiple solutions that use patterns to transfer information.*

- This activity uses two different models to "see" sound waves, and covers discussions of the transfer of information from one material to another through waves.

Materials (per team of 4 to 8 students):

Equipment, provided by NASA:

- Set of 4 Tuning Forks
- Ping pong ball with attached string

Equipment, not provided by NASA:

- Container of Water (plastic food storage container would work well)
- Soft item for activating tuning forks (book spine works well)

Materials (per student):

Printables:

- Tuning Fork Worksheet

Artifact included in this kit:

- Fluid Mechanics Lab "Dimple Car" and Information Sheet

Recommended Speakers from Ames:

Please note that our Speakers Bureau program is voluntary and we cannot guarantee the availability of any speaker. To request a speaker, please visit http://speakers.grc.nasa.gov.

Dean Kontinos (Hypervelocity Air and Space Vehicles)

Ernie Fretter (Arc-Jet, Re-entry Materials)

Mark Mallinson (Space, Satellites, Moon, Shuttle Technology)

Set-Up Recommendations:

- Prepare copies of the **Tuning Fork Worksheet**.
- Set out tuning fork materials for each team:
    - Container with water (plastic food storage container works well)
    - Ping Pong Ball on String
    - Tuning Fork activator (book spine)
- Optional: If you would like to set up more tuning fork stations for the teams or around the classroom, here are some possible ideas:
    - Hold a sheet of paper in one hand and use the other hand to activate the tuning fork
    - Place the handle against the skull bone immediately behind the ear
    - Place the handle on top of other objects
    - Place a piece of masking tape near the top of the vibrating tuning fork

Procedure:

1. Introduce the activity: Scientists and engineers are constantly looking for ways to make vehicles more efficient. Studying wave patterns (airflow, sound, etc.) they can begin to understand and improve on current designs. Sound is produced by a vibrating object. These vibrations produce ***compression waves*** in the air that enter your ear canal. When the compression waves vibrate your eardrum, your brain interprets the vibrations as sound. In this activity, tuning forks will be used to help us understand more about sound.
2. We recommend breaking students into teams of 4 to 8. Pass out the **Tuning Fork Worksheet** to each student.
3. Have students activate each of the four tuning forks. Their tuning forks will range in sound, and each labeled with a number and a letter (ex. 512-C). Explain to students that the numbers refer to the ***frequency*** in Hertz that each fork produces. Explain that ***frequency*** refers to the number of waves that pass a single point in a unit of time. The letter refers to the name of the musical ***pitch*** produced.
4. Compare the pitch of each fork: which ones are higher in pitch? Which ones lower? What causes a pitch to be higher or lower? Have students answer questions 1, 2 and 3 on their **Tuning Fork Worksheet**.
5. Now have students experiment with their tuning forks. On their **Tuning Fork Worksheet**, there are four different experiments that they can try with their tuning forks. If you decided to use extra station ideas, have students use the back of their **Tuning Fork Worksheet** to record observations.

6. At the end of class, discuss how different sounds can come from aircraft and how Green Aviation techniques are working to reduce the noise of aircraft.
    a. Jet Engines: Jet engines create a large amount of noise, especially during take off and landing. Green Aviation engineers and scientists are working to create quieter engines.
    b. Speed/Air movement: the air moving over the wings and fuselage of an aircraft make noise. Green Aviation scientists and engineers are working to reduce this noise by changing the shape of wings and fuselages.
    c. What else can students think of? How would they try to reduce this noise?

Helpful Resources:

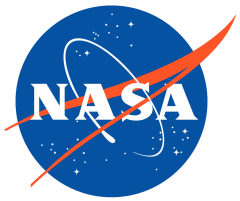
NASA's Green Aviation:
http://www.nasa.gov/centers/ames/greenspace/green-aviation.html

NASA's Aeronautics Home Page:
http://www.aeronautics.nasa.gov/

The Physics Classroom, Soundwaves:
http://www.physicsclassroom.com/mmedia/waves/edl.cfm

Safety:

- Please be careful when activating the tuning forks so that they don't slip out of one's hand.
- The tuning forks do not need a lot of force to be activated. Please do not allow students to use excessive force on the tuning forks.
- Please only use the tuning fork activator (or another soft object, like a book spine) to activate the tuning forks.



Names: _____

Tuning Fork Worksheet

1) Which tuning fork had a lowest pitch, the smallest or largest in your set? Write down the *frequency* and *pitch* of your answer below.

2) Which tuning fork had the highest pitch, the smallest or largest in your set? Write down the *frequency* and *pitch* of your answer below.

3) Based on your answers above, what do frequency and pitch have in common?

4) Tuning fork Stations:
Describe what happens at each station below.

Placing your finger against the vibrating tuning fork:

Placing the vibrating tines of the tuning fork in water:

Placing the handle of the tuning fork on top of your head:

Placing the vibrating tines of the tuning fork against a suspended ping pong ball:

5) After discussing with your class about what scientists and engineers are trying to do to reduce aircraft noise, how else do you think noise could be reduced?

Good Vibrations (Part 2 of 2):

[Adapted from *NASA's Museum in a Box*]

What is it?

The transfer of energy from one material to another can be measured in different ways. One that you may not initially think of is sound. Sound can be good, as it allows us to communicate and interact with our surroundings, but sound can also cause disturbance. For example, because sound is a vibration, it can cause *resonance.* This resonance can be transferred from one part to another. Unwanted vibrations can cause critical parts to break or fail to function.

In this activity, teachers will show a demo of what sound vibrations may look like. After, students will build their own instrument where they can "see" sound.

This activity discusses topics related to National Science Education Standards:

4-PS4-3: *Generate and compare multiple solutions that use patterns to transfer information.*

- This activity uses two different models to "see" sound waves, and covers discussions of the transfer of information from one material to another through waves.

Materials (per class):

Equipment, provided by NASA:

- Thunder Drum

Materials (per team of 2 to 4):

Equipment, provided by NASA:

- Sand
- Plastic Container (to hold the instrument in as to not spill the sand everywhere)
- Pipe Pieces
    - Long stem
    - Elbow
    - Short Stem

Equipment, not provided by NASA:

- Balloons (we recommend buying large ones)
- Scissors

Materials (per student):
Printables:
- Seeing Sound Worksheet

Artifact included in this kit:
- Fluid Mechanics Lab "Dimple Car" and Information Sheet

Recommended Speakers from Ames:

Please note that our Speakers Bureau program is voluntary and we cannot guarantee the availability of any speaker. To request a speaker, please visit http://speakers.grc.nasa.gov.

Jonathan Trent (Environmental Green Team, Chemical and Biology Evolution)

Ronald Thompson (Energy Conservation, Heavy Rescue)

Michael Flynn (Life Support Studies, Water Recycling)

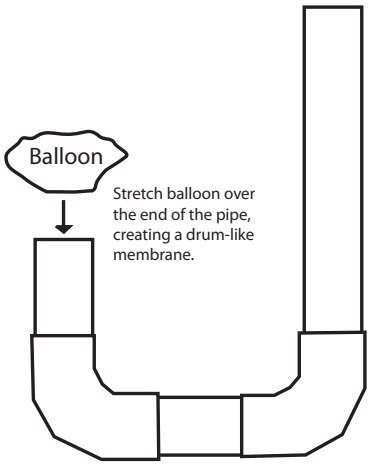
Set-Up Recommendations:
- Prepare copies of the **Seeing Sound Worksheet**.
- Set up the Thunder Drum at the front of the room.
    - To use the drum, place your fingers through the handle slots and shake it with a twisting motion, thus allowing the string to vibrate. You can create a variety of sounds by placing the opposite hand over the top and scrape the spring or strike it while it is in motion to create a variety of sounds.
- Set out Pipe Pieces, Sand, and Balloons for each team.

Procedure:

1. Introduce the activity: Scientists and engineers are constantly looking for ways to make vehicles more efficient. Studying wave patterns (airflow, sound, etc.) they can begin to understand and improve on current designs. Sound is produced by a vibrating object. These vibrations produce ***compression waves*** in the air that enter your ear canal. When the compression waves vibrate your eardrum, your brain interprets the vibrations as sound. The *compression waves* are transferred to your eardrum from the air. Waves can be transferred to different objects in different ways. In this activity, we will "see" sound using two different tools: the Thunder Drum and a plastic pipe horn.
2. We recommend breaking students into teams of 2 to 4. Pass out the **Seeing Sound Worksheet** to each student.
3. Start experimenting with the Thunder Drum. It provides an excellent demonstration of ***resonance***, which occurs when a vibrating object (the drum head) causes another, similar object to vibrate (the spring). Walk around with the drum and let students see what parts of it are vibrating (all parts of the drum

should be vibrating). Have the students answer question 1 on their **Seeing Sound Worksheet**. Students should answer that yes, the vibrations can be transferred from one object to another.

4. Start with a discussion with students about resonance in vehicles. Do they think scientists and engineers would be concerned about resonance? Lead the class discussion to where students understand that unwanted vibrations can cause critical parts to break or fail to function. Resonance from air vibrations around vehicles can cause them to be slower (i.e. the "Dimple Car" experiment). After a few minutes of discussion, have students answer question 2 on their **Seeing Sound Worksheet**.
5. Now, it's time to experiment on their own to "see" sound! Have students assemble their instrument:



   a. Connect the long stem, elbow, and short stem of the pipes so they end up in a lop-sided "U" shape.
   b. Cut the stem off of the balloon, and stretch it over the open end of the short stem (an adult's assistance may be needed for this).
   c. Place the instrument into the plastic container (to contain the sand).
   d. Pour some of the sand onto the balloon as it is inside the container. It may spill off, but that's ok, as students can put more sand back on the balloon from inside the container.
   e. Make different noises into the instrument. What shapes are made on the balloon in the sand? Have students draw three pictures of the patterns of the sand on their **Seeing Sound Worksheet**.
6. After experimenting for a short while, bring the students back for discussion. Why does this happen? Lead the student discussion to the realization that the different sounds they make produce different patterns. The different sounds they make have different ***resonances*** on the balloon. Have students answer the last question on their **Seeing Sound Worksheet**.

Helpful Resources:

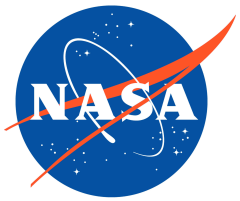
NASA's Green Aviation:
http://www.nasa.gov/centers/ames/greenspace/green-aviation.html

NASA's Aerodynamics Testing (including the Fluid Mechanics Lab):
http://www.nasa.gov/centers/ames/research/area-wind-tunnels_prt.htm

The Physics Classroom, Resonance:
http://www.physicsclassroom.com/class/sound/u11l5a.cfm

Safety:

- Please have the students be careful with the Thunder Drum. Although it's not easy to do, the drumhead can be punctured or the spring could snap.
- Sand can be very messy! Try to have students be careful not to spill the sand, especially because it can be a slipping hazard.



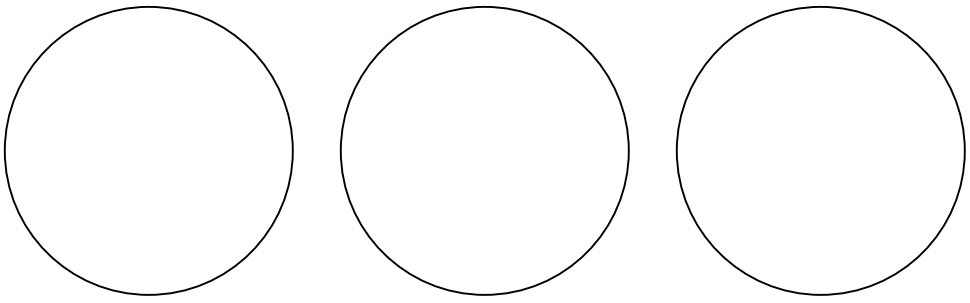
Names: _____

Tuning Fork Worksheet

1) Can energy from the vibrating drumhead with the spring be transferred to other objects through the drum cylinder? Why or why not?

2) Why are engineers very concerned about resonance in the design of vehicles?

4) Draw pictures of the shape of the sand from different sounds you made into your instrument:



5) Why are these three sand shapes different?